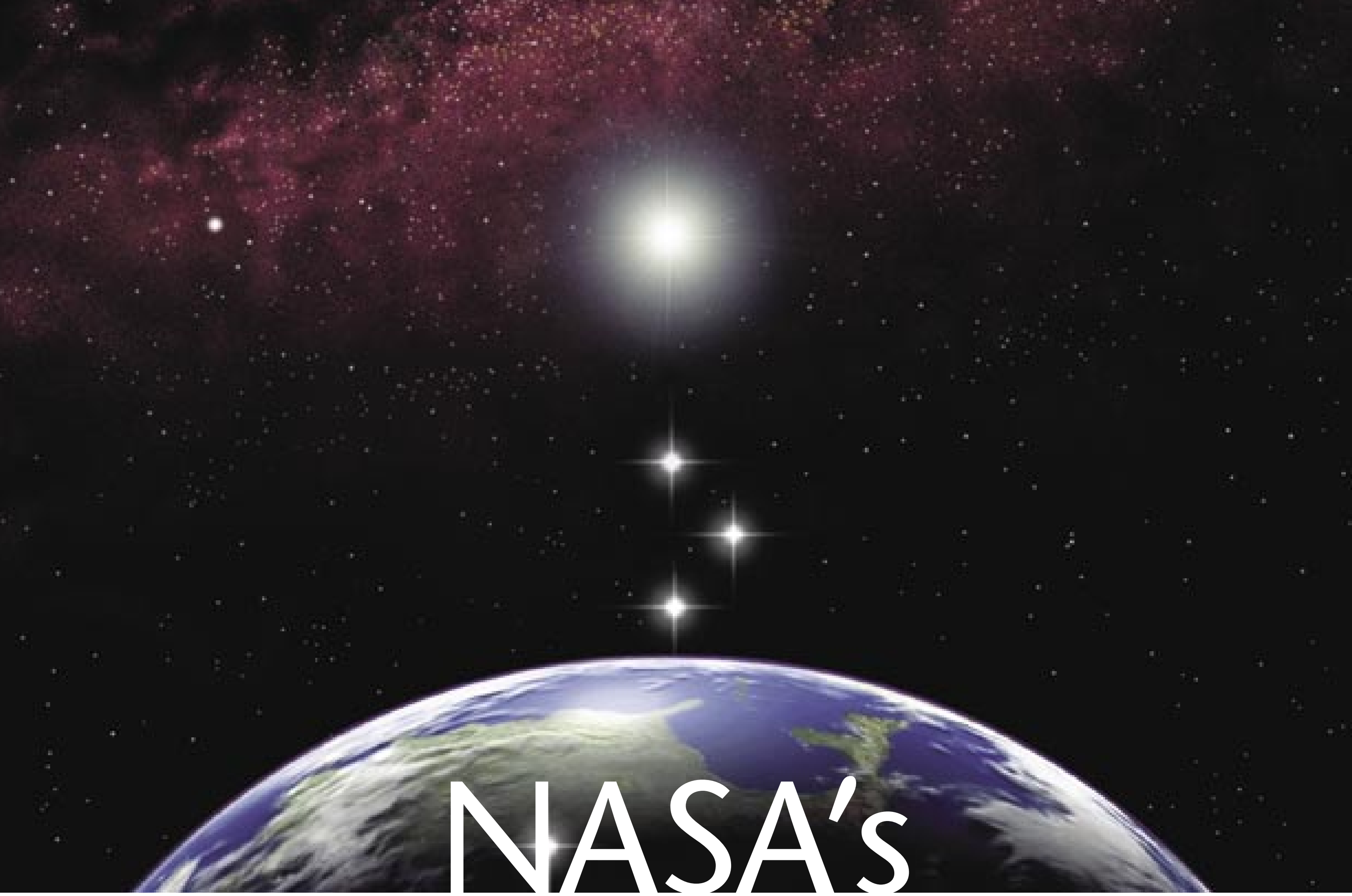



NASA Goddard Space Flight Center

Laboratory for Atmospheres



NASA's Mission

*To understand and protect our home planet,
to explore the universe and search for life, to inspire the next
generation of explorers . . . as only NASA can.*

...One Journey, One Team, One NASA...

http://atmospheres.gsfc.nasa.gov

July 2004

Dr. William K. M. Lau is the Chief of the Laboratory for Atmospheres. He received his Ph.D. in Atmospheric Sciences at the University of Washington in Seattle in 1977. Dr. Lau's research interests include climate dynamics, atmospheric hydrologic processes, air-sea interaction, and climate variability and change.

Dear Readers:

The progress of science depends critically on communications. So does the health and vitality of a science organization. This brochure conveys a number of messages, but its main objective is to spread the word about the Laboratory for Atmospheres.

Inside this brochure you'll find descriptions of our work scope, our people and facilities, our place in NASA's mission, and some of our accomplishments. It is intended to provide a flavor of what the Laboratory is all about. This document is aimed at a wide spectrum of potential readers including managers and colleagues within NASA, scientists outside the agency, graduate students in the atmospheric sciences, and members of the general public. The Laboratory for Atmospheres' mission is the advancement of knowledge and understanding of the atmospheres of the Earth and other planets. Laboratory scientists conduct basic research in atmospheric sciences from the vantage point of space observations and related computer modeling. We also play an active role in developing and calibrating new and improved instruments for spaceflight and field campaigns. We enthusiastically invite you to take a glimpse into the work done by so many dedicated individuals.

A brochure can only attempt to arouse the reader's curiosity. We welcome the opportunity to elaborate on any subject that strikes a responsive chord. Enjoy your journey through the following pages into the world of the Laboratory for Atmospheres.

William K.-M. Lau, Chief
Laboratory for Atmospheres, Code 910

Introduction

The Laboratory for Atmospheres is part of the Earth Sciences Directorate (Code 900) based at NASA's Goddard Space Flight Center in Greenbelt, Maryland. The Directorate is composed of the Global Change Data Center (902); the Global Modeling and Assimilation Office (900.3); the Earth and Space Data Computing Division (930); three laboratories — the Laboratory for Atmospheres (910), the Laboratory for Terrestrial Physics (920), and the Laboratory for Hydrospheric Processes (970); and the Goddard Institute for Space Studies (GISS) in New York, New York.

Mission:

The Laboratory for Atmospheres is dedicated to advancing knowledge and understanding of the atmospheres of the Earth and other planets.

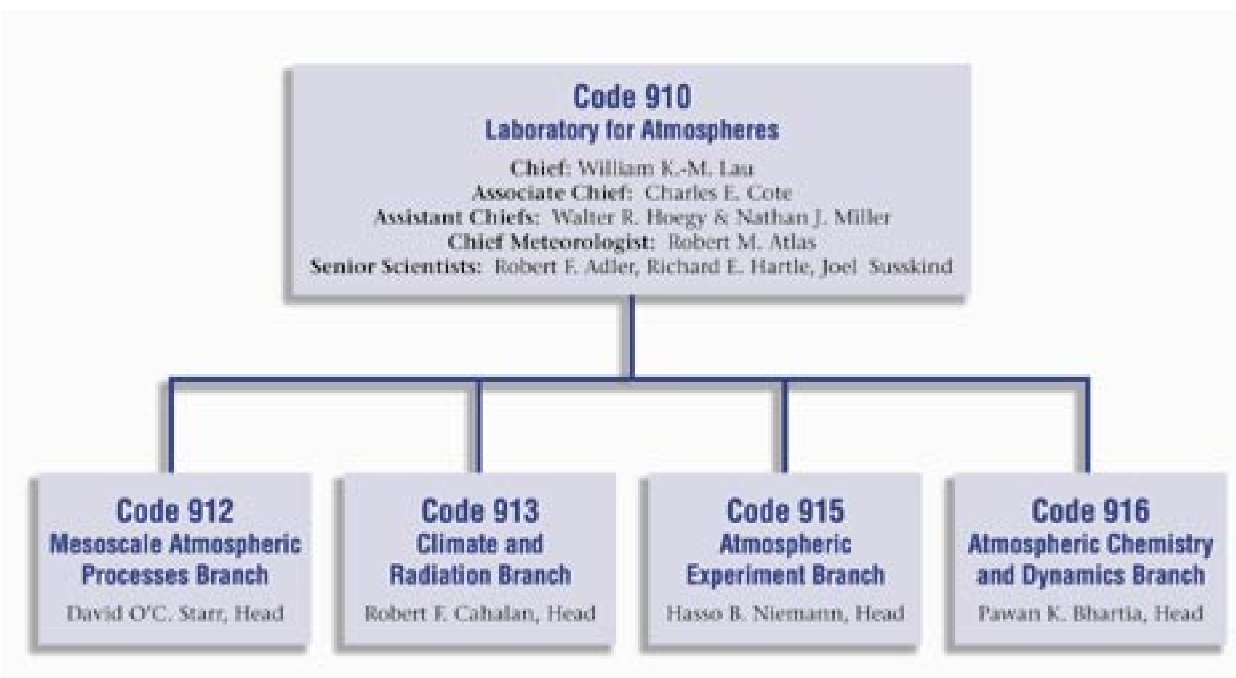
NASA's overall program, as outlined in the Agency's strategic plan, is composed of six enterprises: Earth Science, Space Science, Aerospace Technology, Biological and Physical Research, Exploration Systems, and Space Flight. The Laboratory for Atmospheres concentrates on two of these: the Earth Science and Space Science Enterprises.

Our Organization

The diverse personnel of the Laboratory for Atmospheres are made up of scientists, engineers, technicians, resource analysts, and administrative staff.

The total head count is approximately 304, including civil servants, faculty associates, and contractors. More than 70% of the personnel have a Ph.D. degree in physical sciences, engineering, or related fields.

The Laboratory has traditionally been organized into discipline-oriented branches, even though we increasingly work on science projects that are more interdisciplinary in nature. Major research activities are conducted within four main branches: Mesoscale Atmospheric Processes Branch, Code 912; Climate and Radiation Branch, Code 913; Atmospheric Experiment Branch, Code 915; and the Atmospheric Chemistry and Dynamics Branch, Code 916. In addition, Code 910 senior scientists carry out independent research projects. Research activities of each branch are described in further detail in the following pages.



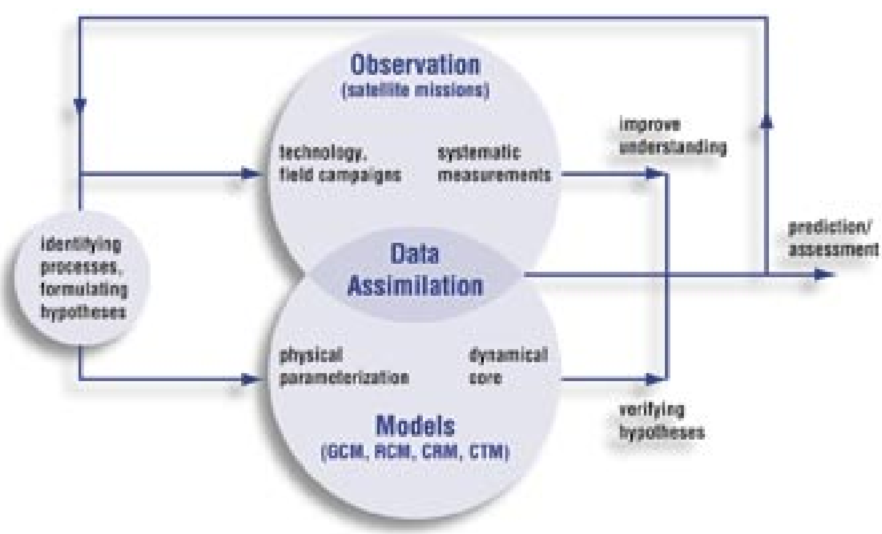
Our Research Strategy

The Laboratory for Atmospheres promotes integrated research combining observations, modeling and data assimilation. Observations consist of data from satellite missions, in-situ and remote sensing data from field campaigns, reanalyses, and long-term monitoring. Laboratory scientists and engineers actively participate in the formulation, planning, and execution of satellite missions and related calibrating and validation experiments. Some serve as project scientists, deputy project scientists, or as science team members of NASA satellite missions, (e.g. TOMS, UARS, Terra, Aqua, Aura, TRMM, GPM, CloudSat, Calipso, QuikSCAT). Others are involved in the development of new measurement technology for laser, radar and passive microwave radiometers. Modeling studies are carried out in coordination with observations, making use of global climate models (GCM), regional climate models (RCM), cloud resolving models (CRM), and chemical transport models (CTM), to study the effects of atmospheric composition, clouds, precipitation and aerosols on the hydrologic cycle and climate change. In conjunction with the Global Modeling and Data Assimilation Office (GMAO), we have developed a state-of-the-art data assimilation capability that can blend satellite data with output from global climate models to provide a comprehensive four-dimensional description of the Earth climate states. Satellite data impact studies and observed system simulation studies are carried out to assess the impact of satellite data on weather and climate predictions. The synergistic use of observations, models and data assimilation, and the iterative processes involved are illustrated in the figure below. No matter what the science issue, (e.g. - effects of atmospheric ozone on the environment, effects of clouds on climate, or impacts of aerosols on the atmospheric water cycle), the approach is the same. The integrated approach is driven by the intellectual process of identifying key processes, formulating of hypotheses, and asking the right science questions. Provided all the "wheels are turning" at the same time, this integrated approach will lead to improvement in predictions and societal impact assessments.

Outside Interactions

Scientists working in isolation cannot achieve the mission of the Laboratory. We pride ourselves on strong collaborations, through joint investigations with other laboratories in the Earth Sciences Directorate, (e.g. Global Modeling and Assimilation Office, the Laboratory for Hydrospheric Processes, the Goddard Institute for Space Studies, and the Laboratory for Terrestrial Physics.) A large number of faculty associates from JCET, GEST, and ESSIC are collocated with us at GSFC, participating in joint research activities. Our engineering colleagues within GSFC and our industrial partners provide science, programming, and technology support. We also promote activities that inspire the next generation of earth scientists through our education programs for graduate, undergraduate, and K-12 students as well as teachers. A number of our scientists teach courses, advise graduate students and/or serve as adjunct faculty at various universities. We have strong collaboration with other government agencies such as NOAA, DOE, ONR and NSF through joint centers, interagency agreements, and joint research projects.

Integrated Approach to research at the Laboratory for Atmospheres



Mesoscale Atmospheric Processes Branch

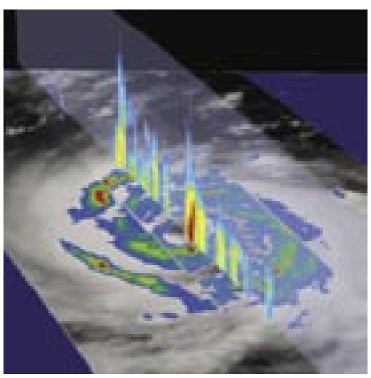
Dr. David O'C. Starr, Head of the Mesoscale Atmospheric Processes Branch, obtained a Ph.D. in Atmospheric Sciences from Colorado State University in 1982. His research interests include upper tropospheric clouds including theoretical (modeling) and observational approaches.

Mission

Weather, climate and the global water-energy cycle are elements of the Earth system affecting life and the sustainability of human societies. Our mission is to characterize and understand atmospheric components of the global water-energy cycle and their linkages to the Earth's weather systems and climate. Toward this end, we develop technology to remotely sense the atmosphere from space and develop computer models for understanding atmospheric processes.

Major Thrusts

Our major scientific thrusts address precipitation, clouds, aerosol-cloud interactions, surface atmosphere interactions, and remote sensing technology development and application, including satellite missions. We develop and make extensive use of cloud system and mesoscale models.



TRMM revealed hydrometeor structure and rainfall distribution of Typhoon Etau over the western Pacific, August 7, 2003.

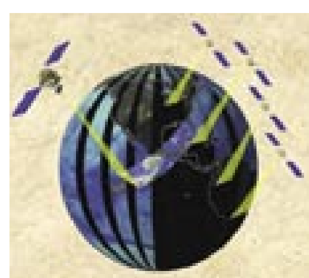
Projects/Activities

Satellite Retrievals: Branch members routinely derive 3-hourly global precipitation fields from data taken by the Tropical Rainfall Measurement Mission (TRMM) and other research and operational satellites. These data are widely used and represent the preeminent global precipitation analysis. We are also deeply involved in developing the Global Precipitation Measurement (GPM) mission to provide high spatial and temporal resolution estimates of global rainfall and latent heating. We provide data on clouds and aerosols derived from the Geoscience Laser Altimeter System (GLAS) on ICESat, launched in 2003. Both of these missions rely heavily on active remote sensing technology and provide unprecedented views of our planet.

Ground Observations: The Branch provides a wide range of unique observing capabilities to the nation. We are home to the new MicroPulse Lidar Network (MPLNET), a federation that provides essential information on the vertical distribution of aerosols and clouds at more than 12 sites around the world. We have developed the Goddard Laboratory for Winds (GLOW), a mobile Doppler lidar system, capable of sensing wind profiles, that is a possible precursor to a satellite system; and the mobile Scanning Raman Lidar (SRL) that provides measurements of water vapor profiles, clouds and aerosols at fine resolution. SRL is regarded as the standard for water vapor profile measurements and is deployed to provide key measurements in support of major field missions and, like MPLNET, validation of satellite measurements.

A slice of the Antarctic atmosphere obtained from NASA's Geoscience Laser Altimeter System (GLAS) the world's first satellite lidar showing multi-level clouds and aerosols.

Airborne Observations: Branch scientists develop advanced active sensor technology and participate in major field experiments on atmospheric processes and validation of satellite measurements. Airborne instruments include the Cloud Physics Lidar (CPL), the ER-2 Doppler Radar (EDOP) and the millimeter-wavelength Cloud Radar System (CRS), all of which have been integrated and deployed on NASA's high-altitude ER-2 aircraft.



The Global Precipitation Mission (GPM) is designed with a core satellite flying with a constellation of satellites to provide accurate global estimates of horizontal and vertical structure of rainfall and microphysics elements.

Scientists gathered in front of NASA's ER-2 during CRYSTAL-FACE – a field campaign conducted in South Florida in July 2002 to study tropical cloud systems.

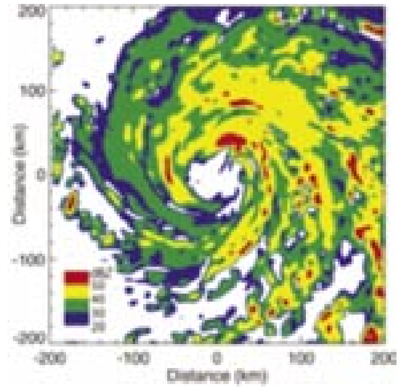
Modeling: We have a strong research group focused on cloud system modeling with special emphasis on precipitating systems. We have developed the Goddard Cumulus Ensemble Model, now implemented on massively parallel systems. We also use MM5 for regional applications and are beginning to transition to the new NCAR/NCEP WRF model. A key area of expertise is on the effects of microphysical processes, and we are also strong in the areas of surface interactions and aerosol effects.

Education and Outreach: Branch members perform services that lie outside their primary science duties. Educational outreach and interaction with the public through media events are two strong areas of our activity. Our Branch routinely hosts many under-graduate and graduate students each year, with our scientists serving as mentors for the students. Several Branch members also serve on graduate student Ph.D. committees. In addition to outreach at Goddard, a number of our scientists reach out to the general public by providing audio-visual demonstrations and E-Theater presentations, and visiting with schools and groups around the world. Branch members are also actively involved in public outreach through various media interactions and press releases.

Dr. Robert Adler, TRMM Project Scientist, discusses the nuances of satellite precipitation estimation with Dr. Marshall Shepherd and Mr. Eric Nelkin.

Research Highlights

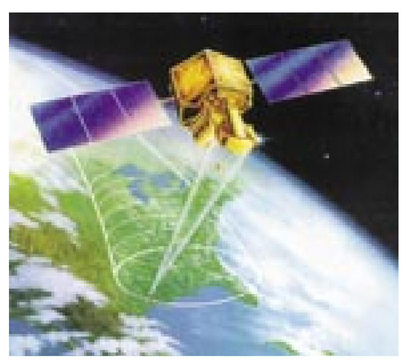
Dr. J. Marshall Shepherd is investigating the effects of cities on rainfall. Using TRMM data, he has found causes for the anomalies and is involved in planning for the Houston Environmental Aerosol Thunderstorm Project, a field experiment that will occur in the summer of 2005. Dr. Shepherd also serves as the GPM Deputy Project Scientist.



Simulated radar reflectivity using a mesoscale model with near-cloud resolving grid spacing of Hurricane Bonnie, revealing unprecedented details including multiple spiral cloud and rain bands.

Dr. Scott Braun is investigating the processes that affect hurricane intensity and precipitation with the goal of improving hurricane prediction. He has been involved in hurricane field projects (CAMEX-4) and has per-formed high-resolution simulations of observed hurricanes. Dr. Braun has documented the impact of near-storm environmental influences in generating eye-wall asymmetries, particularly in deep convection, that may play crucial roles in intensification and the water budget of the storms.

Branch members are highly active in field experiments, most recently participating in the Cirrus Regional Study Cirrus Experiment (CRYSTAL-FACE) and the International H20 Project (IHOP), both in the summer of 2002, and a few smaller efforts every year. We anticipate a major role in the Topical Cloud Systems and Processes (TCSP) experiment in the summer of 2005.



Global Wind Explorer – A mission concept to directly observe the dynamics of the atmospheres using a Doppler lidar to profile wind in the troposphere and stratosphere.

Climate and Radiation Branch

Dr. Robert F. Cahalan, Head of the Climate and Radiation Branch, obtained a Ph.D. in Physics from the University of Illinois-Urbana in 1973. His research interests include chaos and fractals, cloud structure, Landsat and other high-resolution satellites, multiple field-of-view lidar, and solar forcing of earth's climate.

Mission

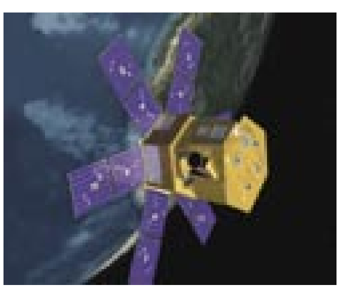
Our mission is to understand climate variability and change, the impact of human activities on climate now and in the future, and how to adapt to and manage climate change impacts on society.

Major Thrusts

Our research covers aerosol-climate interactions, rainfall and cloud radiative processes, solar radiation and surface radiation properties. We use satellite observations in studies of the sensitivity of climate to changes in clouds, aerosols, C02, and S02. Using data from remote sensing and insitu measurements and cloud models, we investigate 3D radiative transfer through inhomogeneous clouds. We develop parameterization of atmospheric hydrologic processes for regional and global climate models.

Projects/Activities

EOS Missions: Branch members derive cloud and aerosol characteristics from data taken by the Moderate Resolution Imaging Spectroradiometer (MODIS) on-board the Terra and Aqua satellites. These data are widely used throughout the international scientific community. Dr. Robert Cahalan is the project scientist for SORCE (Solar Radiation and Climate Experiment).



The SORCE satellite launched in December 2002, measures solar radiation and addresses key scientific issues of long-term climate change, and sun-earth connections.

Airborne Observations: Thickness from Off-beam Returns (THOR), is a laser system with 10 multiple fields-of-view (FOV) photon counting detector channels that can "see through" low-level clouds with large optical thickness. THOR determines not only cloud top height (as can most lidars) but also cloud base height, to an accuracy of 5% or better. The THOR team is led by the Climate and Radiation Branch, and includes participation by other NASA and non-NASA colleagues.

Mr. John Kolasinski and Mr. Kenneth Yetzer working with the THOR lidar system in the NASA P3B, during the AASI sea ice validation campaign in Antarctica in September 2003.

Ground Observations: The Surface-sensing Measurements for Atmospheric Radiative Transfer (SMART) facility instruments measure radiation parameters; and the companion suite of instruments, the Chemical, Optical, and Microphysical Measurements of In-situ Troposphere (COMMIT), measure chemical species. These instruments have been deployed in Puerto Rico, Florida, and Oklahoma to study clouds, aerosols, and air pollution. Data will be used to validate satellite measurements and to better understand the interaction among radiative, hydrologic, and climate variables. The SMART-COMMIT combination will soon head to Southeast Asia to observe smoke and pollution.

Dr. Jack Ji and Ms. Marguerite Barenbrug working on the SMART instruments at the Kruger National Park, Skukuza, South Africa during the SAFARI-2000 field campaign.

Modeling: The modeling effort is used in conjunction with satellite, airborne and ground observations. This opens our eyes to how our natural climate works and how human perturbations can affect it. Branch research efforts are focused on two complementary streams: cloud radiative processes and climate dynamics. Plane-parallel radiation codes are developed for computing radiative effects of clouds, water vapor, and cloud drop-size distribution. For climate dynamics studies, the Branch uses a hierarchy of models ranging from one-dimensional radiative-convective models to coupled atmosphere-ocean-land models.

Research Highlights

Using MODIS satellite data, Branch members show how heavy smoke aerosol in the Amazon basin inhibits cloud production, and how this previously ignored process can change regional smoke radiative effects from cooling to warming.

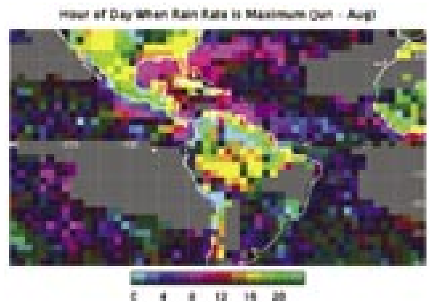
Image of fires raging in southern California and the massive smoke plume emitted by the fires acquired at 18:40 UTC on October 26, 2003 by the MODIS sensor onboard the Terra satellite.

MODIS data were also used for quantitative assessment of the emission, transport and deposition of dust from Africa, showing that 120 tons of dust are deposited annually into the oceans. It is hypothesized that the Saharan dust has a major role in fertilization of the Amazon forest. If that is true, the MODIS data will have resolved an old question about the amount of Saharan dust required for it to serve as the main fertilizer of the Amazon basin. In addition, Saharan dust may contribute to the production of oceanic phytoplankton, which generates dimethyl-sulfide gas that is a precursor of the oceanic sulfate aerosol.

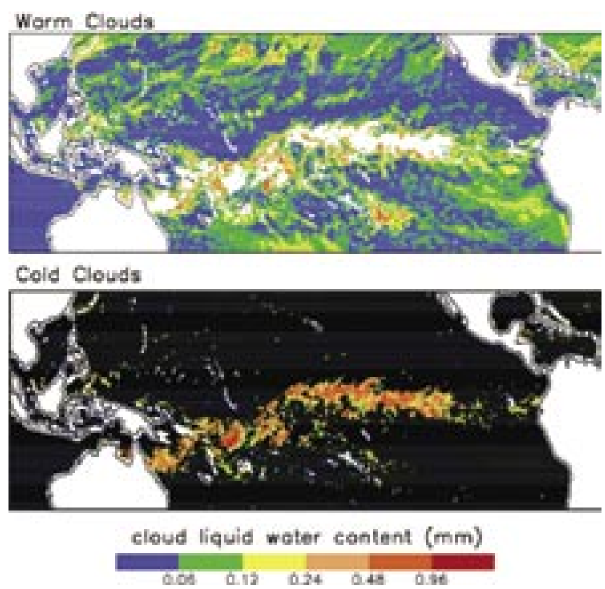
Recently, a method to analyze simultaneous measurements from a spaceborne 2-wavelength lidar and from a spectroradiometer such as MODIS has been introduced. The MODIS data are used to constrain the lidar inversion, thus enabling the retrieval of the aerosol profiles. This method was applied successfully to Saharan dust and smoke from Africa in two field experiments.

References: Kaufman, Haywood, Hobbs, et al., Remote sensing of vertical distributions of smoke aerosol off the coast of Africa, Geophys. Res Lett. Vol. 30, No. 16, 1831, 10.1029/2003GL017068, 16 August 2003; Kaufman, Tanré, Léon and Pelon, Retrievals of profiles of fine and coarse aerosols using lidar and radiometric space measurements, IEEE TGRS, 41, 1743-1754, 2003.

Analyses of TRMM cloud liquid water and rainfall data have shown that warm rain comprises more than 30% of the total rain in the tropical oceans, much more prevalent than previously recognized, and that warm rain efficiency may increase in a warmer climate, causing changes in the atmospheric water cycle.



Most probable hour of rain estimated from TRMM data.



False-color maps, derived from TRMM data, showing average distributions of liquid water in warm clouds (top) and cold clouds (bottom) over the tropical Pacific for January 1-3, 1988.

Reference: Lau and Wu, 2004: Warm Rain Processes and Climate Implications. Geophys. Res. Lett., 30(24), 2290, 10.1029/2003GL018567.

Atmospheric Experiment Branch

Dr. Hasso B. Niemann, Head of the Atmospheric Experiment Branch, obtained a Ph.D. in Electrical Engineering from the University of Michigan in 1969. His research interests include planetary atmospheres, aeronomy, gas-surface interactions, atmospheric chemical composition, density and temperature measurements, space flight mass spectrometry, electronic systems, and ultrahigh vacuum technology.

Mission

Our mission is to increase scientific understanding of the chemical environment in our solar system during its formation and of the physical processes that have continued to shape solar system bodies through time. The Atmospheric Experiment Branch carries out experimental investigations to further our understanding of the formation and evolution of various solar system objects such as planets, their satellites, and comets. Investigations address the composition and structure of planetary atmospheres, and the physical structure of phenomena occurring in the Earth's upper atmosphere. We have developed and are constantly refining neutral gas, ion, and gas chromatograph mass spectrometers to measure atmospheric gas composition using entry probes and orbiting satellites.

Major Thrusts

The Branch develops unique instruments to make detailed in situ measurements of chemical composition of solar system bodies such as comets, planets and planetary satellites. Unique laboratory teams and facilities built up over several decades of space exploration are in place to conduct this development.

Projects/Activities

Mass Spectrometer experiments have been conducted on:

- Pioneer Venus Orbiter in 1978
- Galileo Probe in 1989 – entered Jupiter's atmosphere in 1995
- Cassini Orbiter and Huygens Probe in 1997 – to enter Titan's Atmosphere in 2005
- Nozomi Mars Orbiter in 1998
- CONTOUR comet flyby mission in 2002

Future Opportunities include:

- Mars Science Laboratory; New Frontiers Venus Lander and Comet Sample Return; Discovery Venus Atmospheric Probe and Comet missions.
- Astrobiology focus with Titan, Mars and comet missions; participation in the Astrobiology Institute.
- Advanced technology development includes highly miniaturized mass spectrometers and gas chromatograph mass spectrometer using MEMS-based technology.

As a result of the President's new vision on Ex-ploration, the exploration of the Moon and Mars will be a major new focus for NASA. For Mars, the science driver for landed missions in 2009 and be-yond is to ultimately answer the question "is there or was there ever life on Mars?" The systematic approach NASA has taken to answer this question is to explore the Mars system in greater detail from orbit and the surface and then address the question of present or past habitability of this planet in even greater detail. One of the highly successful Mars Exploration Rover discovered mineralogical and morphological evidence at the Mars surface of past aqueous conditions. Future investigations will not only "follow the water", but will carry out a search for reduced carbon species and make more comprehensive mineralogical and isotopic measurements to address habitability (Picture courtesy of JPL)

Research Highlights

The Branch provides post-launch support for several key planetary missions including:

A Gas Chromatograph Mass Spectrometer on the Cassini-Huygens Probe mission to explore the atmosphere of the Saturn moon, Titan. Extensive preparations are in progress for the upcoming Saturn/ Titan encounter. The Saturn orbit insertion is scheduled for July 1, 2004. The Probe release to Titan is scheduled for December 25, 2004, and Probe entry into the atmosphere of Titan will occur on January 14, 2005. Existing instrument calibration facilities were prepared for pre-and post-flight calibration of the Flight Spare instrument and are available in our laboratory to simulate flight environments and to assist in the interpretation of the expected flight data.

Branch member Mr. Ed Patrick working on a molecular beam calibration system.

An Ion and Neutral Mass Spectrometer on the Cassini Orbiter to explore the upper atmosphere of both Saturn and Titan. The Ion and Neutral Mass Spectrometer was designed, built, and calibrated by the Branch. Past and current activities focus on participation by Branch personnel in the science planning and preparations for Saturn encounters. The Branch engineering team is also participating in the flight instrument health assessm ent, preparations for pre-and post-encounter, and laboratory calibration of an identical spare instrument.

A Neutral Mass Spectrometer on the Japanese Nozomi mission to explore the upper atmosphere of Mars. A solar flare struck the spacecraft electronic system in April 2002. The Branch science and engineering teams cooperated with the Japanese Nozomi project team to re-establish the health of the spacecraft and to recover from the damaging effects caused by the solar flare.

Branch member Dr. Daniel Glavin shown analyzing Mars analogues on a Laboratory GCMS.

Branch members continue advanced development of measurements for future missions. These include: (1) a probe of the deep atmosphere of Venus to carry out precision measurements of isotopes to resolve questions of the origin and processing of this atmosphere, (2) a detailed in-situ rendezvous mission with the nucleus of a comet, to better understand the complexity of organic molecules that might have been delivered to Earth over the course of its history, and (3)a landing experiment on Mars to sample isotopes and molecules, from its atmosphere and below its surface, to address studies of past climate and the possibility of past life on this planet.

Dr. Daniel Glavin was hired in November 2003 to work on astrobiology projects in the Branch, particularly relating to extraction of complex organic molecules from Mars samples.

Galileo Probe entry into Jupiter's atmosphere, December 7, 1995.

Atmospheric Chemistry and Dynamics Branch

Dr. Pawan K. Bhartia, Head of the Atmospheric Chemistry and Dynamics Branch, obtained a Ph.D. in Physics from Purdue University in West Lafayette, Indiana in 1977. His research interests include remote sensing of trace gases in the Earth's atmosphere.

Mission

The branch develops remote-sensing techniques and computer models to study aerosols, ozone and other trace gases in the Earth's atmosphere to understand the effect of human activities on global climate and chemistry.

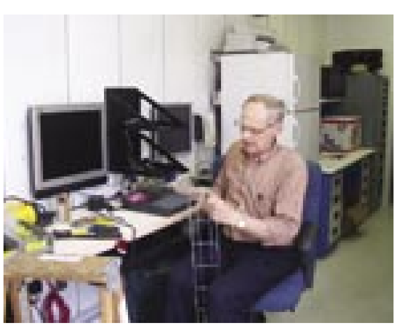
Major Thrusts

Branch scientists have pioneered the development of ultraviolet remote sensing techniques to measure ozone, sulfur dioxide, carbon dioxide, and aerosols in the Earth's atmosphere. Current capabilities include both passive and active (LIDAR) sensors. Future priorities are the development of instrumentation for monitoring air quality and greenhouse gases from high vantage point orbits, including geostationary and Lagrange points. In addition, the branch is developing both active and passive instruments for remote-sensing of trace gases from un-piloted aircraft.

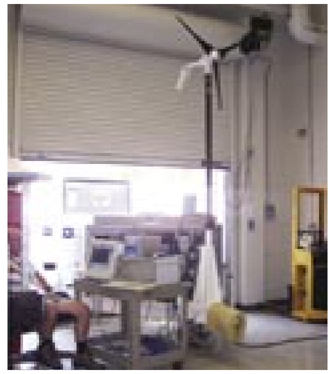
Branch scientists have developed state-of-the-art computer models to study the transport and chemistry of aerosols and trace gases in the Earth's atmosphere. This activity is conducted in close collaboration with the GMAO in the Earth Sciences Directorate. Future priorities include predicting the recovery of polar ozone depletion (ozone hole), understanding the exchange of water vapor and trace gases at the tropospheric-stratospheric boundary, and air quality research.

Projects/Activities

TOMS/SBUV/OMI: The Total Ozone Mapping Spectrometer project, led by P. K. Bhartia, is one of the longest-running Earth observation projects at NASA. Along with its companion instrument SBUV, it has produced data sets for atmospheric ozone, aerosols, UVB (285-325nm), volcanic sulfur dioxide, and Tropospheric ozone, spanning more than 3 decades. Dr. Bhartia is the US Science Team Leader of OMI, a hyperspectral UV/Visible instrument contributed by the Netherlands for flight on EOS Aura in 2004. In addition to continuing the venerable TOMS data series, this instrument is designed to measure several trace gases relevant to air quality. Future missions include OMPS, a suite of 3 instruments for mapping and profiling ozone, that is scheduled to fly on NASA's NPP satellite mission in late 2006, and on the NPOESS meteorological satellite series, starting in 2009.



Mr. Don Silbert preparing the Stratospheric Ozone Lidar for it's next deployment to Table Mountain, California.



The Kiritimati Island Lidar Trailer (KILT) being tested at Goddard in Building 33.

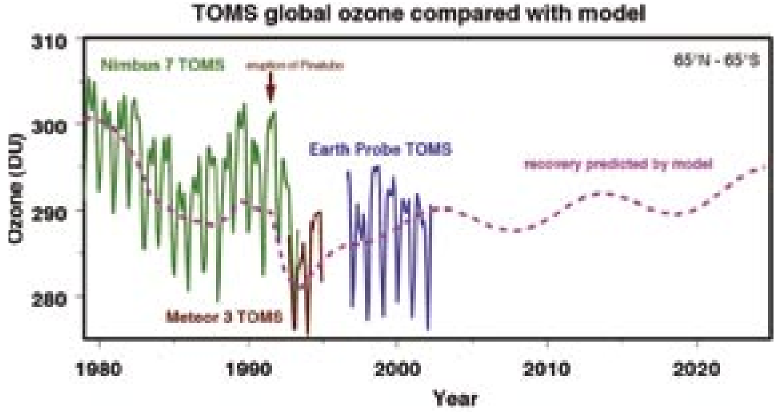
Global Modeling Initiative: This initiative is to develop advanced models for atmospheric chemistry and aerosol research by active participation of scientific experts from academic and government institutions throughout the country. Recently, Goddard was assigned the responsibility to coordinate this project. The responsibility is shared between this Branch and the Earth and Space Data Computing Division of the Earth Sciences Directorate.

Aircraft Missions: The Branch has led several NASA aircraft missions to study the chemistry and dynamics of the stratosphere. Dr. Paul Newman was one of the two Project Scientists for the second SAGE III Ozone Loss and Validation Experiment (SOLVE II) field campaign held in early 2003. Dr. Tom McGee flew with the Airborne Raman Ozone Temperature and Aerosol Lidar (AROTAL) instrument onboard the aircraft. The purpose of this Campaign was to study ozone loss in the arctic spring and to validate SAGE III data. SAGE III-Stratospheric campaign was to study ozone loss in the artic spring and to validate SAGE III data. The instrument from NASA's Langley Research Center was flying onboard a Russian spacecraft.

Research Highlights

Aerosol radiative forcing is one of the largest uncertainties in assessing global climate change. To understand the various processes that control the aerosol properties and to understand the roles of aerosols in atmospheric chemistry and climate, Dr. Mian Chen has developed an atmospheric aerosol model, the Global Ozone Chemistry Aerosols Radiation and Transport (GOCART) model. In the past few years, the GOCART model has been used to study tropospheric aerosols and their impact on air quality and climate forcing. Major types of aerosols, including sulfate, dust, black carbon, organic carbon, and sea-salt are simulated. Among these, sulfate, black and organic carbon mainly originate from human activities such as fossil fuel combustion and biomass burning. Dust and sea-salt are mainly generated by natural processes, for example, uplift of dust from deserts by strong winds.

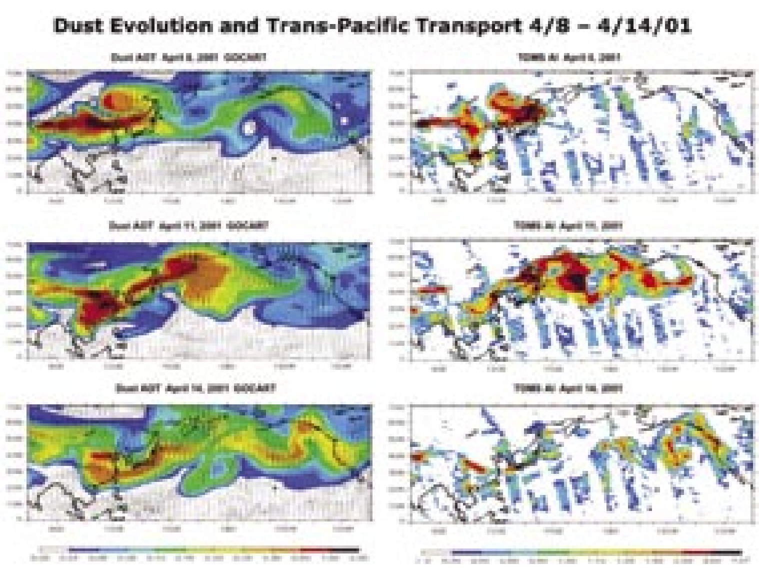
The modeling activities have always been strongly connected to the satellite and aircraft observations. Our recent research involves studies of intercontinental transport of dust and pollutants using a combination of model calculations and data from satellite observations (from MODIS and TOMS), a ground-based network (AERONET), and in-situ measurements (ACE-Asia). The aerosol absorption properties derived from the GOCART model are used for studies of air pollution, radiation budget, tropospheric chemistry, hydrological cycles, and climate change.



Time series of total ozone from historical data (solid), and simulations and predicted recovery (dotted line) by the GSFC 2D model.

The aerosol radiative forcing is also obtained from assimilated products of the model and MODIS data, and calibrated against AERONET data.

There are several ongoing research projects using the Goddard Space Flight Center (GSFC) Two-dimensional (2D) Model. One timely project involves the computation of the atmospheric influence of the several very large solar proton events in the past four years, 2000-2003. Six of the nine largest events in the past 40 years occurred in this period in solar cycle 23. The protons associated with these events can perturb the Polar Regions creating HO_x (H, OH, HO_2) and NO_x (N, NO, NO_2), which can in turn deplete ozone. There were satellite measurements by the HALOE SBUV/2 instruments that showed significant influences on the polar mesosphere and upper stratosphere during several of these events. The GSFC 2D Model predictions were in reasonable agreement with the observations. Regions of disagreement are being studied further. Insight into these model/ measurement discrepancies could lead to model improvements.



Dust evolution and transport across the Pacific Ocean during ACE-Asia. Left column: GOCART dust AOT (with GMAO 4 km wind superimposed). Right column: TOMS absorbing aerosol indices.

Acronyms

ACE-Asia:	Aerosol Characterization Experiment-Asia
AERONET:	Aerosol Robotic Network
Aqua:	EOS satellite helping understand Earth's water cycle and our environment
AROTAL:	Airborne Raman Ozone, Temperature, and Aerosol Lidar
CALIPSO:	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CAMEX-4:	Convection And Moisture EXperiment-4
CloudSat:	Spaceborne radar helping study interior structure, composition, and climate effects of clouds
COMMIT:	Chemical, Optical, and Microphysical Measurements of In-Situ Troposphere
CPL:	Cloud Physics Lidar
CRM:	Cloud Resolving Models
CRS:	Cloud Radar System
CRYSTAL-FACE:	Cirrus Regional Study of Tropical Anvils and Cirrus Layers -Florida Area Cirrus Experiment
CTM:	Chemical Transport Model
DOE:	Department of Energy
EDOP:	ER-2 Doppler Radar
EOS:	Earth Observing System
ESSIC:	Earth System Science Interdisciplinary Center
GCE:	Goddard Cumulus Ensemble model
GCM:	Global Circulation Model
GEST:	Goddard Earth Sciences and Technology center
GLAS:	Geoscience Laser Altimeter System
GLOW:	Goddard Lidar Observatory for Winds
GOCART:	Global Ozone Chemistry Aerosol Radiation Transport
GPM:	Global Precipitation Measurement
GSFC:	Goddard Space Flight Center
HALOE:	Halogen Occultation Experiment
HEAT:	Houston Environmental Aerosol Thunderstorm project
ICESat:	Ice, Cloud, and Land Elevation Satellite
JPL:	Jet Propulsion Laboratory
IHOP:	International H20 Project
JCET:	Joint Center for Earth Systems Technology
LIDAR:	Light Detection and Ranging
MM5:	Mesoscale Model 5
MODIS:	Moderate Resolution Imaging Spectroradiometer
MPLNET:	Micro Pulse Lidar Network
NCAR:	National Center for Atmospheric Research
NCEP:	National Center for Environmental Prediction
NOAA:	National Oceanic Atmospheric Administration
NPOESS:	National Polar Orbiting Environmental Satellite System
NPP:	NPOESS Preparatory Project
NSF:	National Science Foundation
OMI:	Ozone Monitoring Instrument
OMPS:	Ozone Mapper and Profiler System
ONR:	Office of Naval Research
QuikSCAT:	(NASA's) Quick Scatterometer Satellite
RCM:	Regional Climate Models
SAGE III:	Stratospheric Aerosol and Gas Experiment III
SBUV:	Solar Backscatter Ultraviolet
SMART:	Surface-sensing Measurements for Atmospheric Radiative Transfer
SOLVE II:	SAGE III Ozone Loss and Validation Experiment
SRL:	Scanning Raman Lidar
TCSP:	Tropical Cloud Systems and Processes
THOR:	cloud THickness from Offbeam Returns
TOMS:	Total Ozone Mapping Spectrometer
TRMM:	Tropical Rainfall Measuring Mission
UARS:	Upper Atmosphere Research Satellite

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